

**ADVANCED GCE****CHEMISTRY**

Chains, Rings and Spectroscopy

**2814/01**

Candidates answer on the question paper

**OCR Supplied Materials:**

- *Data Sheet for Chemistry* (inserted)

**Other Materials Required:**

- Scientific calculator

**Thursday 11 June 2009****Afternoon****Duration:** 1 hour 30 minutes

Candidate Forename		Candidate Surname	
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Centre Number						Candidate Number				
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**INSTRUCTIONS TO CANDIDATES**

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

**INFORMATION FOR CANDIDATES**

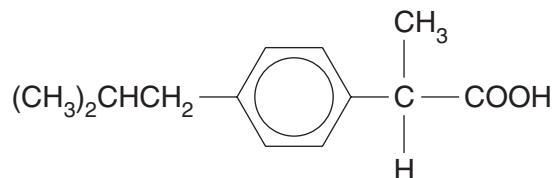
- The number of marks is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is **90**.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.
- This document consists of **20** pages. Any blank pages are indicated.

**FOR EXAMINER'S USE**

Qu.	Max	Mark
1	12	
2	14	
3	11	
4	11	
5	11	
6	12	
7	9	
8	10	
<b>TOTAL</b>	<b>90</b>	

Answer **all** the questions.

- 1 Ibuprofen is a highly successful anti-inflammatory drug. The structure of ibuprofen is shown below.



- (a) Ibuprofen is sometimes sold as the sodium salt of the compound shown above.

- (i) State a reagent that would convert the structure above into the sodium salt.

..... [1]

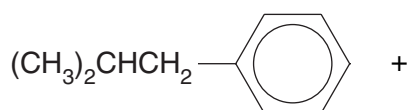
- (ii) Draw the structure of the sodium salt of ibuprofen.

[1]

- (b) Ibuprofen is synthesised by the drug company from smaller molecules.

Starting from the molecule shown below, complete the equation to show how you could synthesise ibuprofen in one step by a Friedel–Crafts reaction.

Identify any essential reagents and conditions.



..... [3]

- Using ibuprofen as an example, explain what is meant by the term *chiral*;
- Discuss the possible disadvantages of producing a chiral drug as a mixture of stereoisomers.

..... [6]

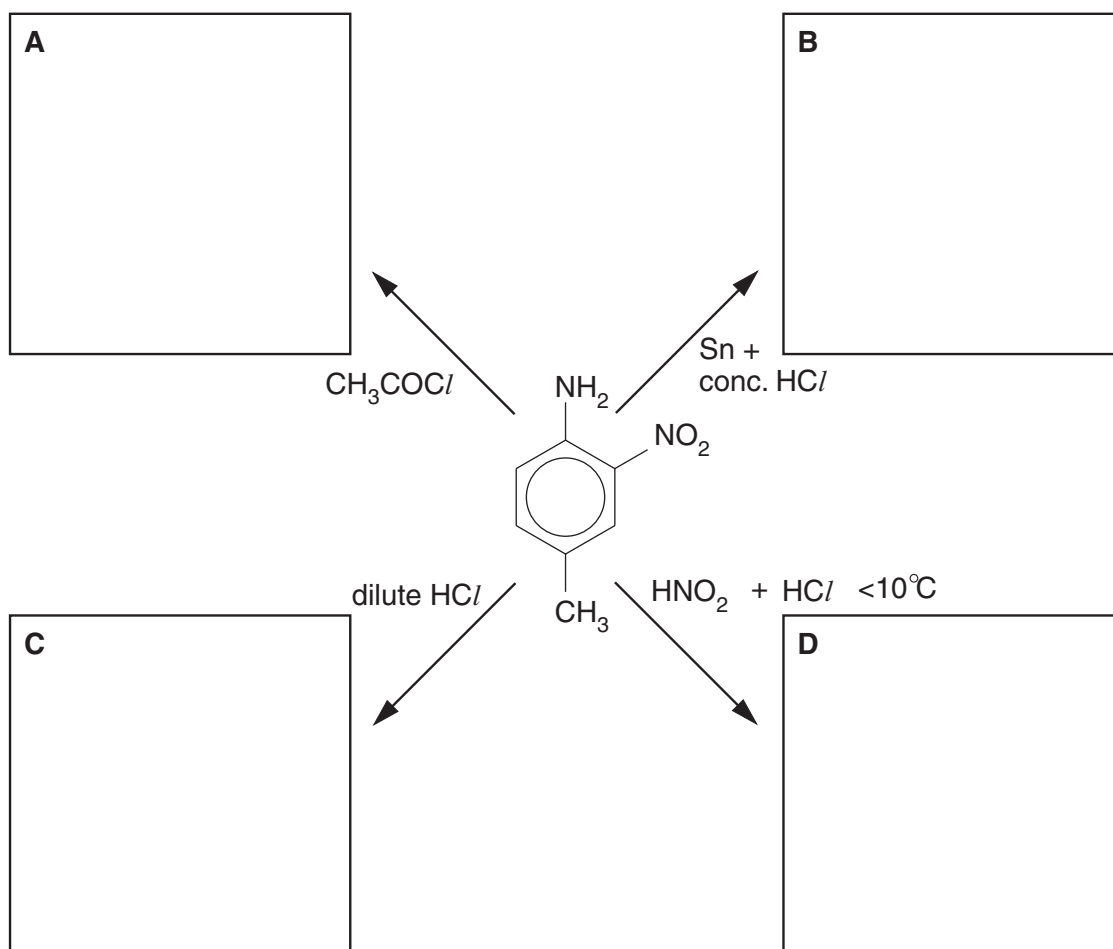
**[Total: 12]**

2 4-Methyl-2-nitrophenylamine is used in the manufacture of pharmaceuticals and dyes.

(a) The diagram below shows some reactions of 4-methyl-2-nitrophenylamine.

Complete the diagram to show the structure of the organic product in each of the reactions below.

[4]



(b) One of the products above can be converted into an azo dye.

(i) State how you would convert the product you have drawn in **D** above into an azo dye.

.....  
 ..... [2]

- (ii) Draw the structure of the azo dye that would be formed in (i).

[2]

- (c) 4-Methyl-2-nitrophenylamine can be synthesised from methylbenzene. One stage involves the mononitration of methylbenzene using nitric acid in the presence of a concentrated sulphuric acid catalyst.

- (i) Complete the **overall** equation for this reaction.



[1]

- (ii) Explain how the concentrated sulphuric acid catalyst is involved at the start of this reaction. Write an equation to illustrate your answer.

.....  
 .....  
 ..... [2]

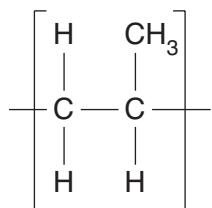
- (iii) Outline the mechanism for the substitution of the nitro group into methylbenzene, showing relevant curly arrows.

[3]

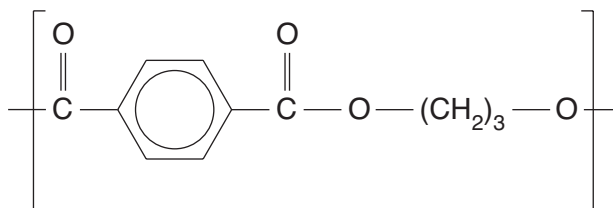
[Total: 14]

Turn over

- 3 Poly(propene) and PTT are two polymers used in the manufacture of carpets. The repeat units of these two polymers are shown below.



poly(propene)



PTT

- (a) Draw each repeat unit as a skeletal formula.

[2]

- (b) State and explain the type of polymerisation used to make poly(propene) and PTT from their monomers.

poly(propene) .....

.....

PTT .....

..... [2]

- (c) Draw the structures of two monomers that could be combined to give PTT.

[2]

- (d) The properties of poly(propene) fibres can be improved by blending strands of isotactic and syndiotactic forms of the polymer.

Draw 3-D diagrams to show the difference between isotactic and syndiotactic poly(propene).

[3]

- (e) Forensic scientists can use infra-red spectroscopy to identify small amounts of carpet fibres left on the shoes of people at the scene of a crime.

Give the wavenumber ranges of **two** absorptions you could use to distinguish between the infra-red spectra of poly(propene) and PTT.

.....  
.....  
..... [2]

[Total: 11]

4 Nitriles are particularly useful in organic synthesis because they can increase the number of carbon atoms in the compound.

- (a) One way of introducing a nitrile into an organic compound is by the nucleophilic addition of hydrogen cyanide to a carbonyl compound such as propanone.

Describe the mechanism for this reaction, showing curly arrows, dipoles and relevant lone pairs.

[5]

- (b) Nitriles can be converted into primary amines and into carboxylic acids.

Describe how you can make a primary amine and a carboxylic acid in separate reactions from propanenitrile,  $\text{CH}_3\text{CH}_2\text{CN}$ .

For each reaction, include:

- an equation;
- any essential reagents and conditions;
- the type of reaction involved.

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..... [6]

[Total: 11]



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**TURN OVER FOR QUESTIONS 5–8**

5 2-Aminopropanoic acid,  $\text{CH}_3\text{CH}(\text{NH}_2)\text{COOH}$ , occurs widely in living organisms.

(a) (i) State how you could form 2-aminopropanoic acid from 2-chloropropanoic acid.

.....  
..... [1]

(ii) Write an equation for this reaction.

..... [1]

(b) In living organisms, most of the 2-aminopropanoic acid either exists as a zwitterion or is used to make peptides.

(i) Draw the structure of the zwitterion of 2-aminopropanoic acid.

[1]

(ii) Write an equation to show how a dipeptide is formed from 2-aminopropanoic acid.

[2]

(c) Occasionally, poly(2-aminopropanoic acid) has been found in human cells.

(i) Draw a repeat unit to show the structure of this polymer.

[1]

- (ii) Outline how a sample of this polymer could be broken down into 2-aminopropanoic acid in the laboratory and state the type of reaction involved.

.....  
 .....  
 ..... [2]

- (d) 2-Aminopropanoic acid can be identified by its n.m.r. spectrum in  $D_2O$ .

The presence of  $D_2O$  will remove the absorption from the  $-NH_2$  and the  $-OH$  group.

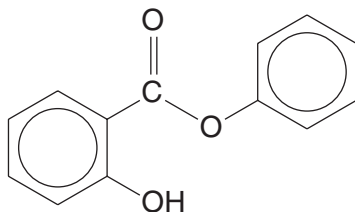
Predict the number of peaks and their relative peak areas on the n.m.r. spectrum of 2-aminopropanoic acid in  $D_2O$ .

Identify the parts of the molecule responsible for each peak.

.....  
 .....  
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 ..... [3]

[Total: 11]

- 6 Phenyl 2-hydroxybenzoate is an ester used in the manufacture of cleaning products. It has also been used as an antiseptic in cosmetics.



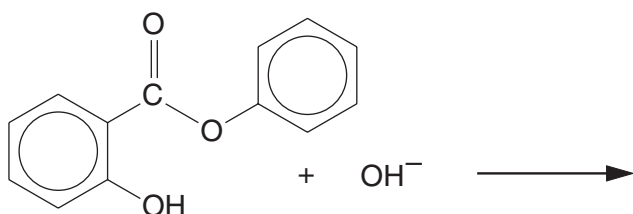
**phenyl 2-hydroxybenzoate**

- (a) Circle the part of the molecule responsible for the antiseptic properties of phenyl 2-hydroxybenzoate. [1]
- (b) Phenyl 2-hydroxybenzoate can be made from 2-hydroxybenzoic acid and phenol by heating the two compounds strongly together.

Write an equation for this reaction.

[2]

- (c) Complete and balance the equation for the alkaline hydrolysis of phenyl 2-hydroxybenzoate.



[3]

(d) Cleaning products based on phenol have occasionally caused bad tasting water. This is because phenol reacts readily with the chlorine used in water purification.

(i) State the type of reaction that occurs between phenol and chlorine.

..... [1]

(ii) Suggest the structure of the product that forms that causes bad tasting water.

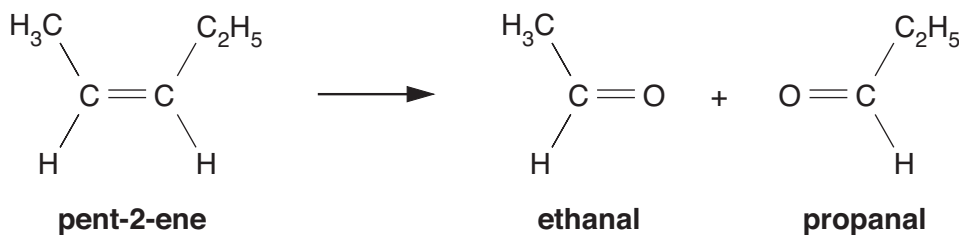
[1]

(iii) Explain why chlorine reacts much more readily with phenol than it does with benzene.

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..... [4]

[Total: 12]

- 7 Alkenes can be oxidised to give carbonyl compounds. This reaction breaks the carbon chain at the C=C double bond as shown in the example below.



- (a) (i) Outline a test you could carry out in the laboratory to show that the carbonyl compounds produced in this reaction were aldehydes.

.....  
 .....  
 ..... [1]

- (ii) Describe a non-spectroscopic method that would enable you to distinguish between the two aldehydes above.

.....  
 .....  
 .....  
 .....  
 ..... [3]

- (b) Identify the products you would expect if the following alkenes were oxidised in a similar way.

- (i) Pent-1-ene.

..... [1]

- (ii) 2-Methylbut-2-ene.

..... [2]

- (c) An unknown cycloalkene with molecular formula  $C_7H_{12}$  was oxidised using the method above. The only organic product was 2-methylhexane-1,6-dial.

(i) Draw the structure of 2-methylhexane-1,6-dial.

[1]

(ii) Identify the cycloalkene.

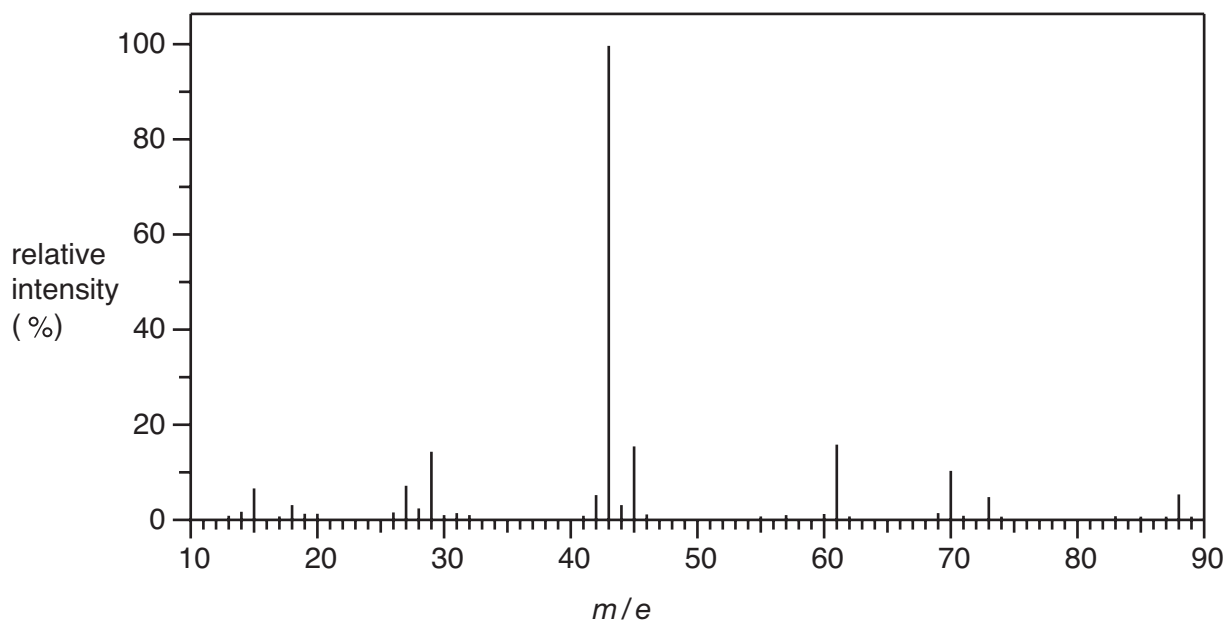
[1]

[Total: 9]

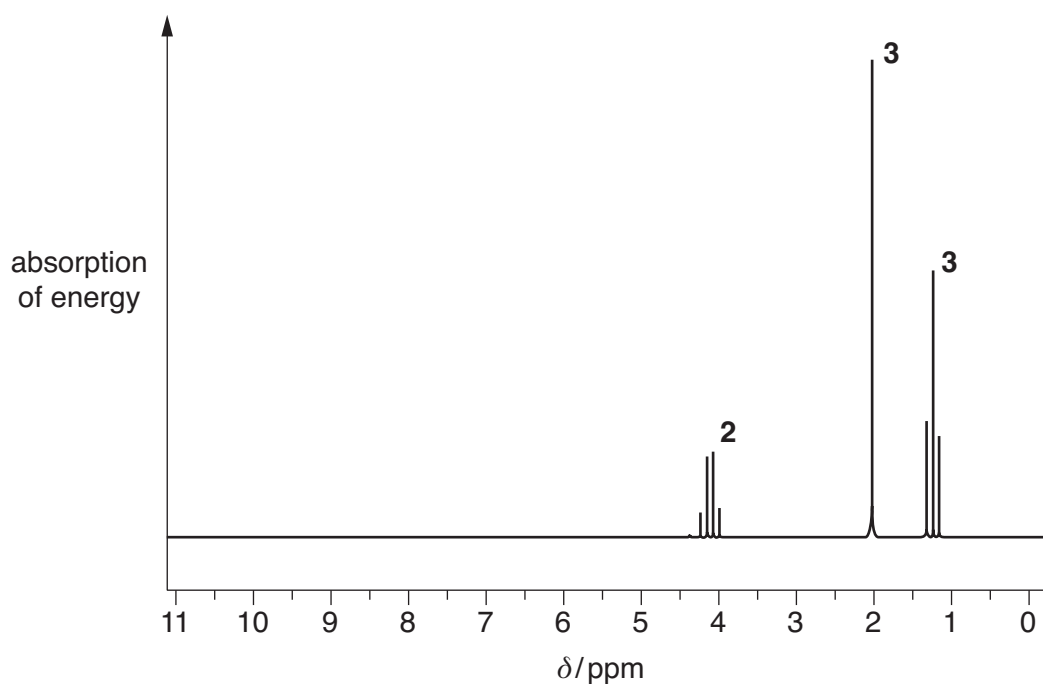
- 8 In this question, one mark is available for the quality of use and organisation of technical terms.

An unknown compound **X** containing 54.5% carbon, 9.1% hydrogen and 36.4% oxygen was analysed by different spectroscopic methods.

The mass spectrum of compound **X** is shown below.



The high resolution n.m.r. spectrum of compound **X** is shown below.



Use the information above to identify compound **X** by deducing:

- its molecular formula;
- its structural formula.

Show all your working and account for the chemical shifts and splitting of each peak on the n.m.r. spectrum.



**[Total: 10]**

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